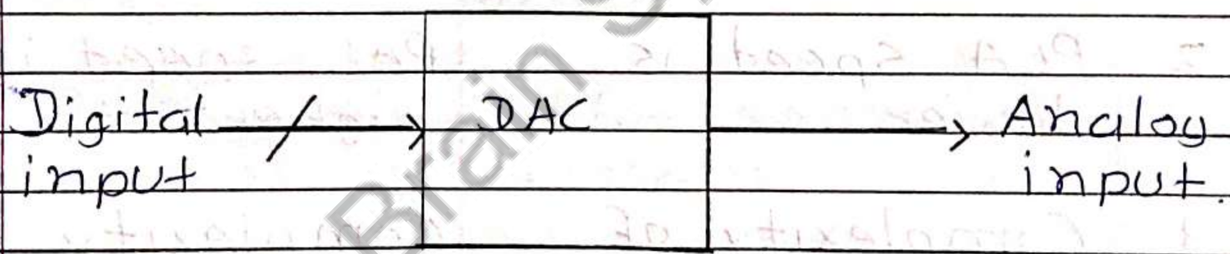
* Digital to Analog Converters:

A Digital to Analog Converter converts a digital input signal into an analog output signal.

The Digital signal is represented with a binary code, which is combination of bits 0 and 1.

→ Block Diagram:



→ Types of Digital to Analog converters:

There are two types of Digital to Analog converters.

1) Weighted Resistor DAC

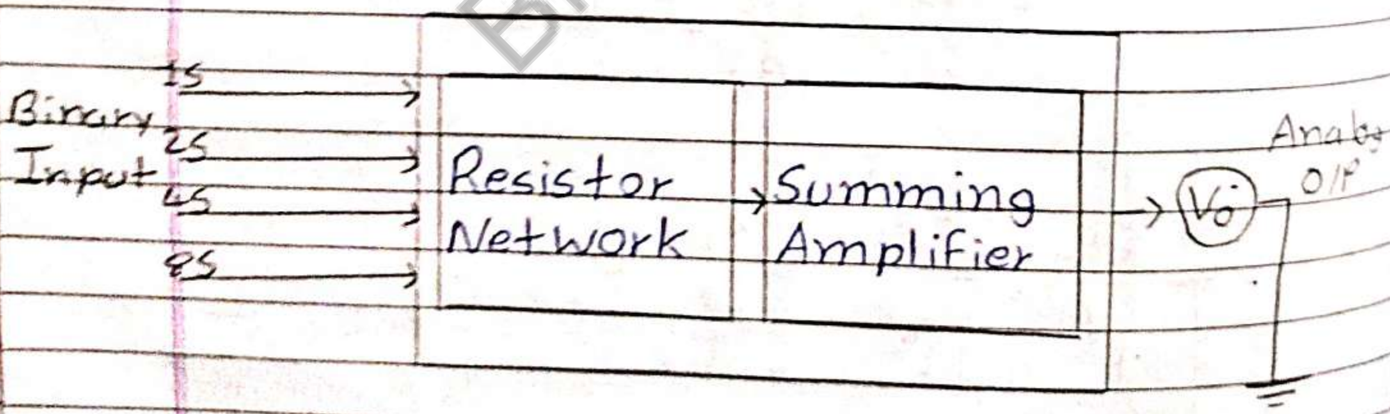
2) R - 2R Ladder DAC.

1 Weighted Resistor DAC:

A weighted Resistor DAC produces an analog output which is almost equal to digital input signal by using binary weighted Resistor.

Binary Weighted Resistor is a type of Data converter which converts a digital binary number into a equivalent analog output number.

→ Block Diagram:



Digtal to Analog Converters converts into two circuits.

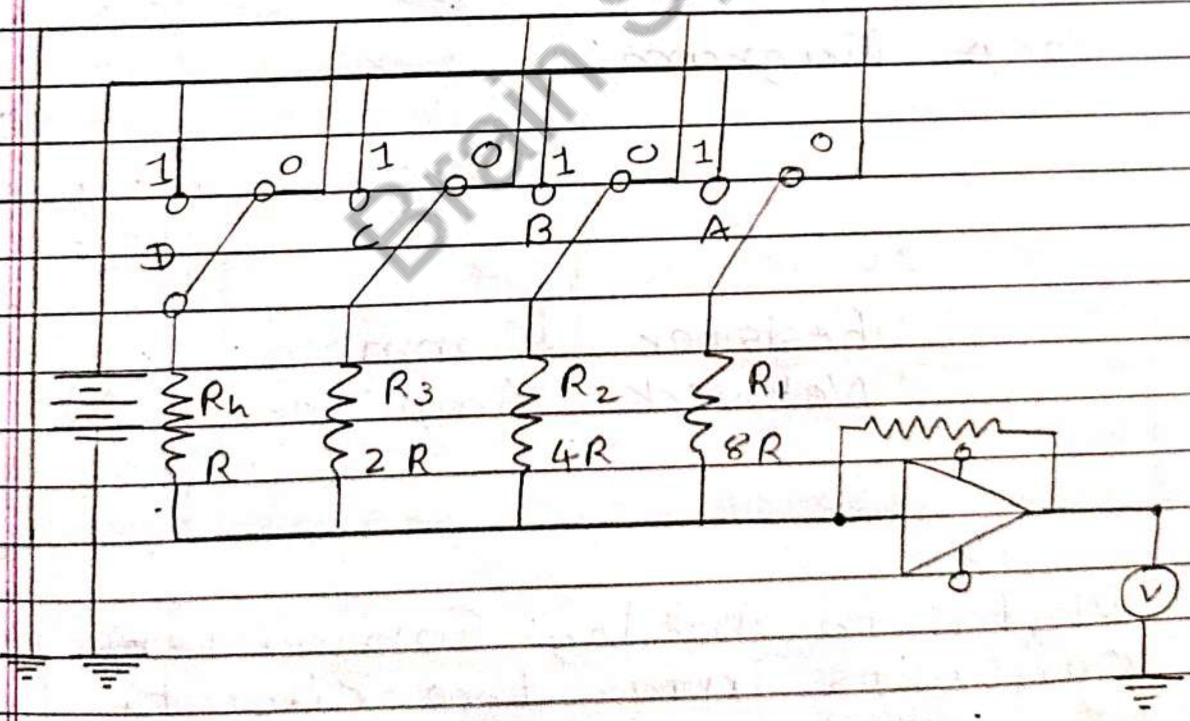
1) Resistor Network
2) Summing Amplifier

The analog output voltage is monitored with a voltmeter.

In Resistor Network most lowest Resistor value is called Most Significant Bit.

In Resistor Network most highest Resistor value is called Least Significant Bit.

→ Circuit Diagram:



In this ckt Diagram,

Most lowest Resistor value is

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R_4. So, R_4 is a Most Significant Bit in the Resistor Network.

Most highest value is R_1. So, R_1 is a Least Significant Bit in the Resistor Network.

→ When all the Bit are high in the ckt then,

Current for A Bit $I_0 = \frac{V_{in}}{8R}$

Current for B Bit $I_1 = \frac{V_{in}}{4R}$

Current for C Bit $I_2 = \frac{V_{in}}{2R}$

Current for D Bit $I_3 = \frac{V_{in}}{R}$

Total Current in the Ckt,

$$I = I_0 + I_1 + I_2 + I_3$$

$$= \frac{V_{in}}{8R} + \frac{V_{in}}{4R} + \frac{V_{in}}{2R} + \frac{V_{in}}{R}$$

$$= \frac{V_{in}}{R}(0.125 + 0.25 + 0.5 + 1)$$

$$I = 1.875 \frac{V_{in}}{R}$$

→ When Bit are low in the Ckt then,

Total Current $I = 0$

⇒ Advantages:

Binary Weighted Resistor is simple in construction and Provides fast conversion.

⇒ Disadvantages:

It is difficult to design more accurate resistor in the Resistor Network.

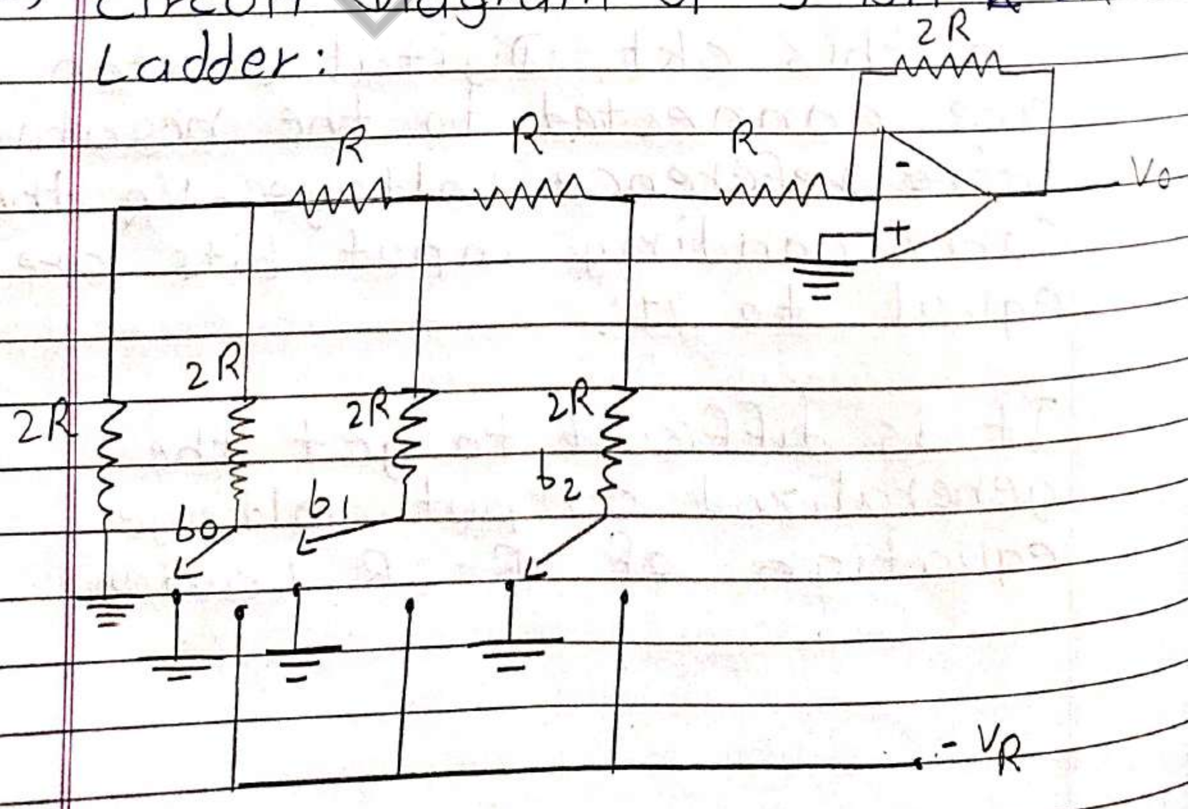
2 R- 2R Ladder DAC:

R- 2R Ladder is remove the disadvantage of binary Weighted Resistor to design more accurate resistor.

R- 2R Ladder is produces an analog output, which is almost equal to digital input signal by using Ladder.

The R-2R Ladder network uses just two Resistor value R and 2R.

→ Circuit Diagram of 3-Bit R-2R Ladder:



This is a 3 bit binary input R-2R Labber so input is b_2, b_1 and b_0.

In this ckt Diagram,

b_2 input is denoted by Most Significant Bit.

b_0 input is denoted by Least Significant Bit.

In this ckt, Digital switch are connected to ground then corresponding input bits are equal to '0'.

In this ckt, Digital switch are connected to the negative ~~refre~~ reference voltage $-V_R$ then corresponding input bits are equal to '1'.

It is difficult to get the generalized output voltage equation of R-2R Ladder.

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=> Advantages:

R-2R Ladder DAC consists only two values of resistor so, it is easy to select accurate resistor design.

=> Disadvantages:

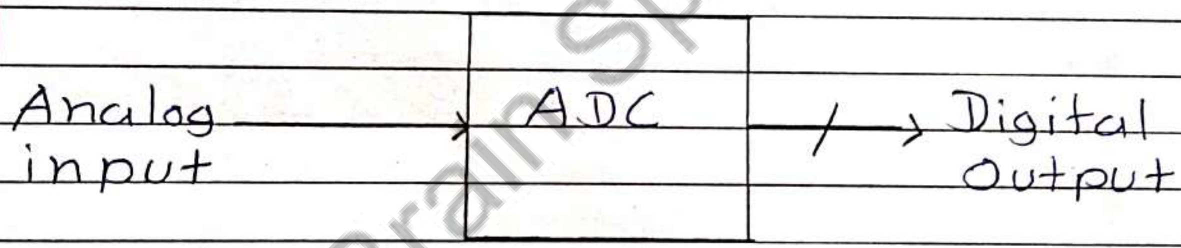
R-2R Ladder DAC requires one unique value per binary input bit.

* Analog to Digital Converters:

An Analog to Digital Converter converts an analog signal into a digital signal which is a combination of bits 0 and 1.

The Analog signal is represented with a binary code.

-> Block Diagram:



-> Types of Analog to Digital Converters.

There are two types of Analog to Digital Converters.

1) Direct type ADCs

2) Indirect type ADCs

1 Direct type ADCs.

There are three types of Direct ADCs.

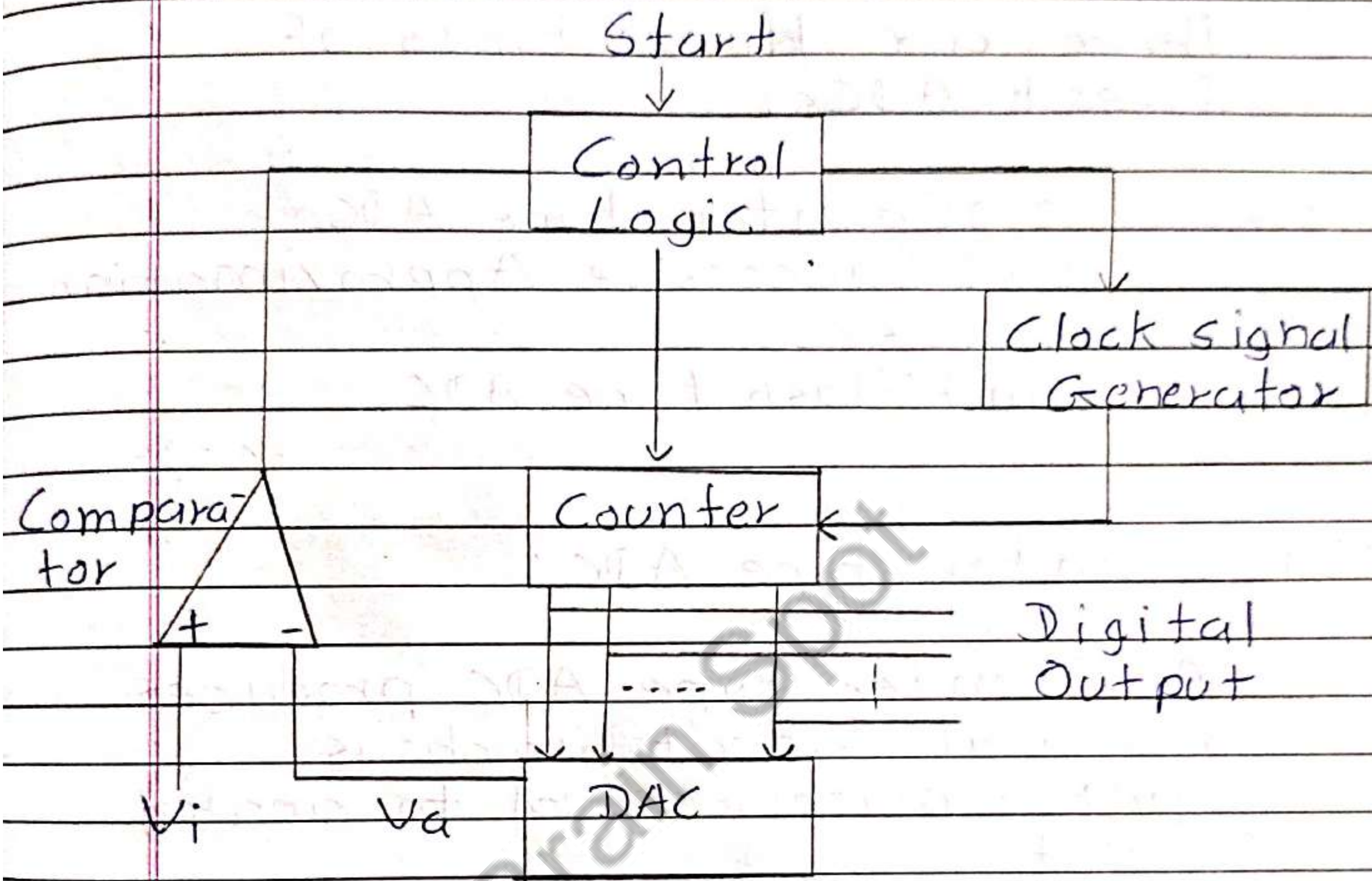
(i) Counter type ADC
(ii) Successive Approximation ADC
(iii) Flash type ADC.

(i) Counter type ADC:

A Counter type ADC produces a digital output which is approximately equal to analog input.

A Counter type ADS produces a digital output using Comparator and Counter operation.

-> Block Diagram:



This counter type ADC consist Comparator, Counter, Control Logic, Clock Signal Generator and DAC.

=> Working:

The Control logic reset the counter and enables to clock signal and send a clock pluse to the counter.

Counter gets incremented by every clock pluse and its binary format output applied as an input of DAC.

DAC converts the received binary input into the analog output.

Comparator compares the analog value V_a with external analog input V_i

If $V_i > V_a$, then output comparator will generate ~~'0'~~ '1'.

If $V_i < V_a$, then Output Comparator will generate ~~'1'~~ '0'.

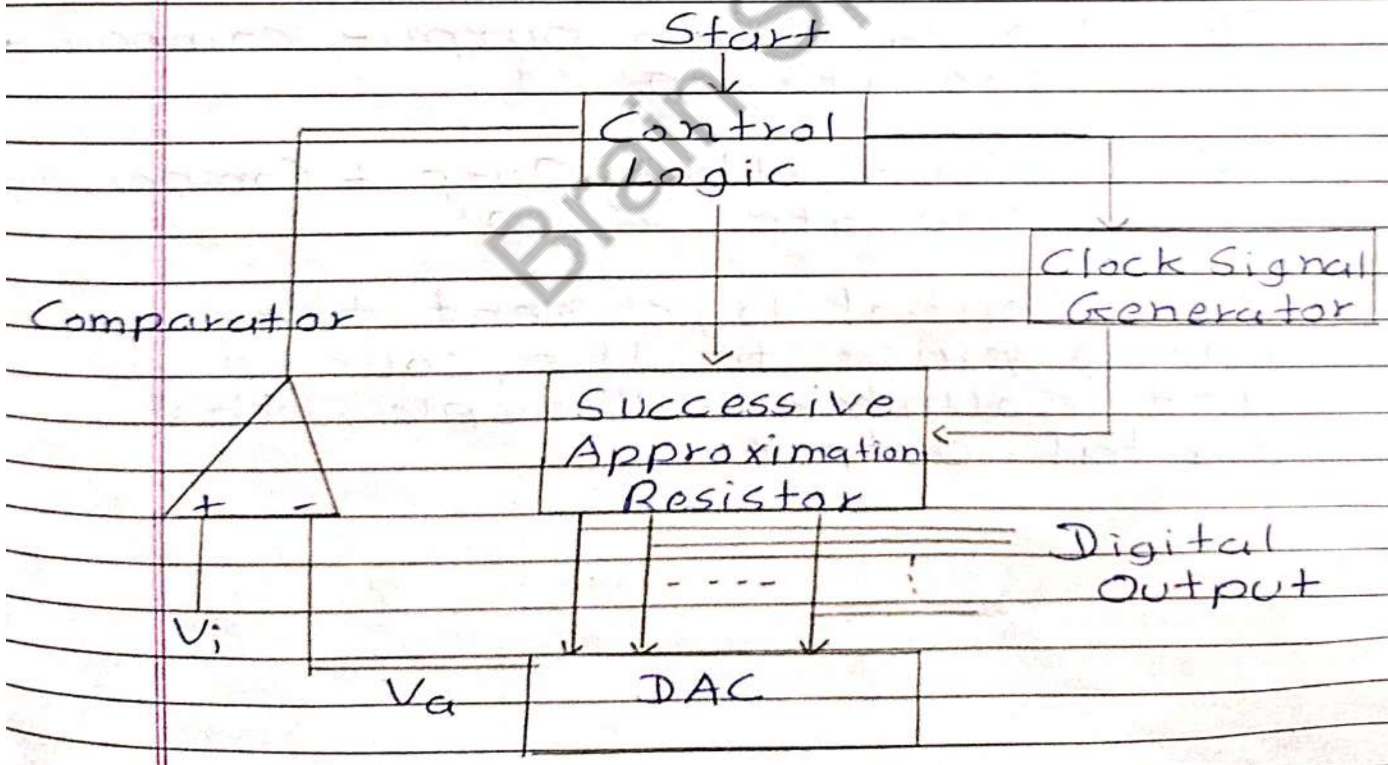
And Control logic send the clock pluse to the counter and counter will display the digital output.

(ii) Successive Approximation ADC:

A Successive Approximation ADC produces a digital output which is approximately equal to analog input.

A Successive Approximation ADC produces a digital output using Successive Approximation method.

→ Block Diagram:



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This Successive Approximation ADC consist Comparator, Control Logic, Clock signal Generator, Successive Approximation Resistor and DAC.

=> Working:

Control Logic reset the Successive Approximation resistor and enable to clock signal to send a clock pluse to the successive Resistor.

Successive Approximation Resistor Update clock pluse and binary formate output applied as a input of DAC.

DAC converts the received binary input into the analog output.

Comparator compares the analog value V_a with external analog value V_i.

If $V_i > V_a$ then Output Comparator generates '1'.

If $V_i \leq V_a$, then Output Comparator generates '0'.

After that control logic send SAR with clock plue and SAR display the digital output.

(iii) Flash type ADC :

A Flash type ADC produces an equivalent digital output for a corresponding analog input.

A Flash type ADC produces an digital output using Priority Encoder.

This a 3-bit Flash type ADC Circuit diagram.

The 3-bit Flash type ADC consist a voltage divider network, 7 comparators and a priority encoder.

=> Working :

The voltage divider Network contains 8 equal resistor. V_R voltage is applied entire the network.

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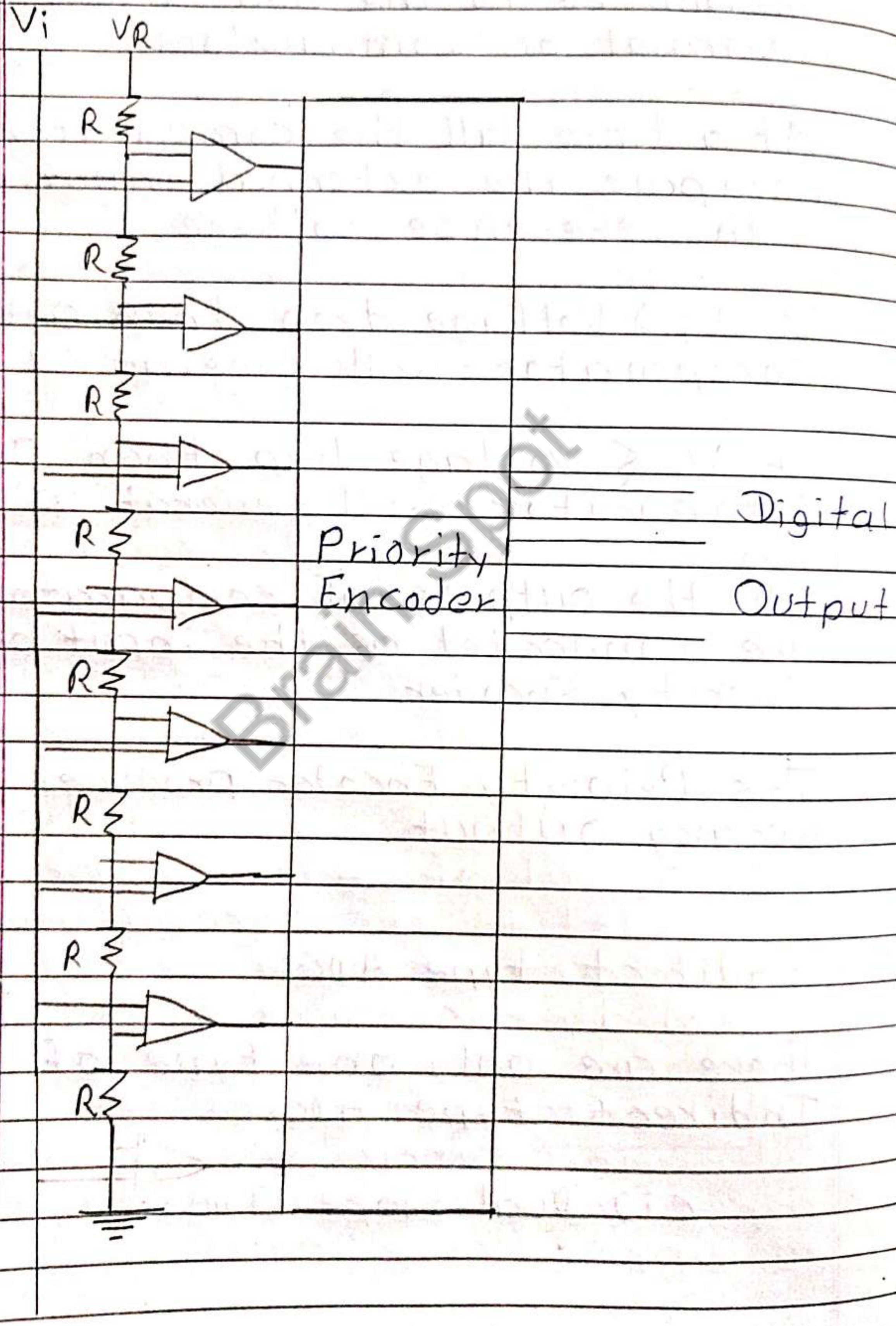
→ Ckt Diagram:



The external input voltage V_i is applied to the non-inverting terminal of comparators.

At a time, all the comparator compare the external input with reference voltage.

If $V_i >$ Voltage drop, then Output Comparator will generat '1'.

If $V_i \leq$ Voltage drop, then Output Comparator will generat '0'.

All the outputs of comparators are connected as the input of Priority Encoder.

This Priority Encoder produces a binary output.

2 Indirect type ADC:

There are only one type of Indirect type ADC.

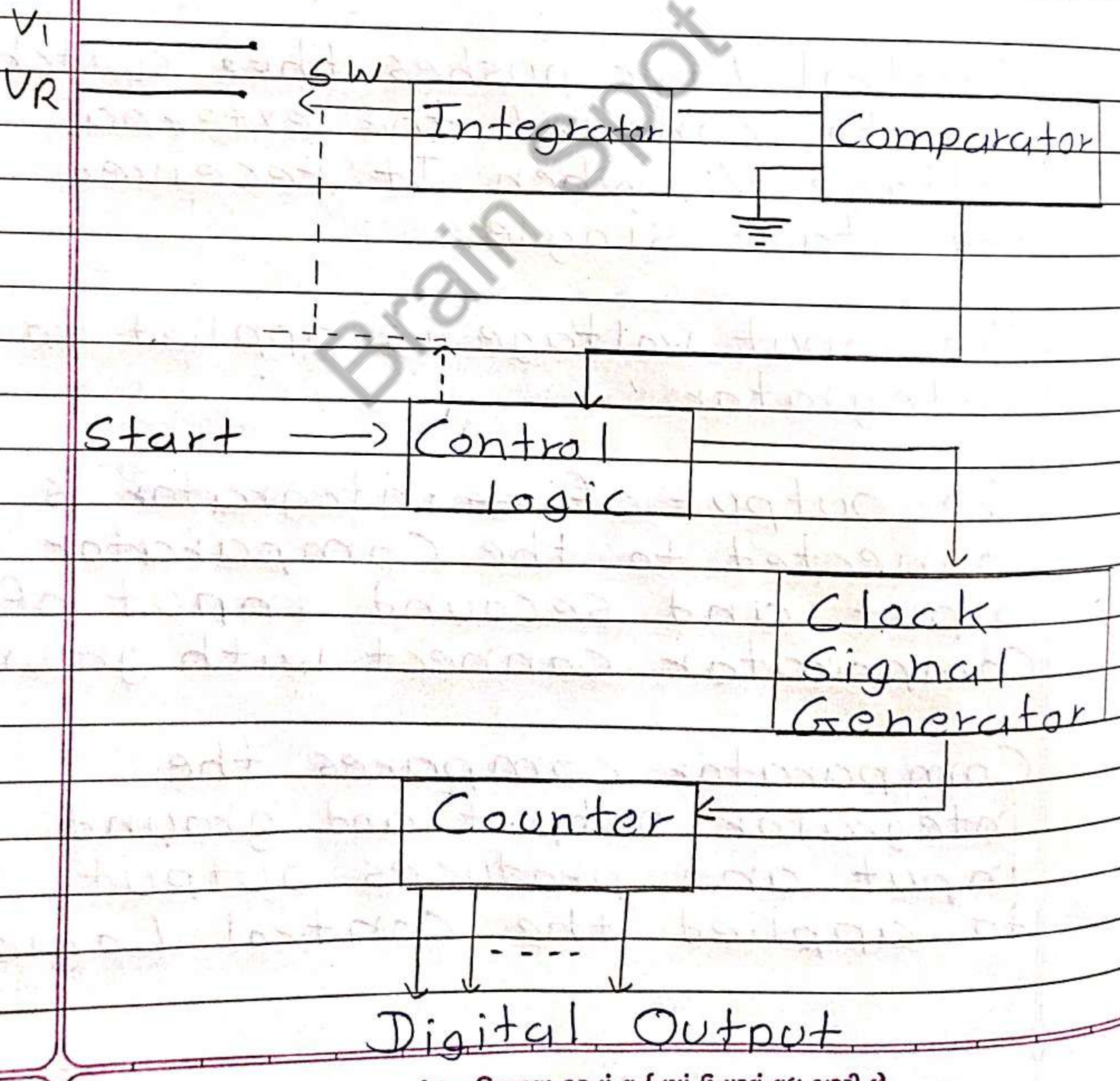
(i) Dual Slope ADC.

(i) Dual Slope ADC:

A Dual Slope ADC produces an equivalent digital output for a corresponding analog input.

A Dual Slope ADC produces an digital output using Dual Slope Technique.

=> Block Diagram:



The Dual Slope ADC consist Integrator, Comparator, Clock signal generator, Control Logic and Counter.

=) Working:

Control Logic resets the counter and enable to clock signal to send the clock pluse to the Counter.

Control Logic pushes thes switch SW to connect the external voltage V_i when It received the start single.

The input voltage is applied to Integrator.

The output of integrator is connected to the Comparator input and secound input of Comparator connect with ground.

Comparator compares the integrator output and ground input and produces output to applied the control Logic.

The counter get increment by clock pluse and Control logic push switch sw to connect negative reference voltage.

The negative reference voltage applied to Integrator and remove charge until it become zero.

The output of Integrator become input of Comparator and Comparator compare the both input having zero volts.

So, Comparator send a signal to control logic. Control logic ~~enable~~ disable to clock signal. and holds counter value.

The counter value is display output as a digital signal.